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A Syllabus of Lectures

on

DARWINISM and EVOLUTION

by

DR. M. F. GUYER.

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OF NATURAL HISTORY.

Syllabus of a Course of Illustrated Lectures

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DARWINISM and EVOLUTION

By

DR. MICHAEL F. GUYER.

These lectures are open to the public and a cordial invitation is extended to all persons interested.

SIX LECTURES—FRIDAY EVENINGS
at 8:00 P. M. in CUNNINGHAN HALL.
April 18th, and 25th. May 2d, 9th, 16th and 23rd.

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COLLATERAL READING.

It is recommended that the student read one or more of the following books on Darwinism and Evolution:

Wallace: Darwinism.

Darwin: Origin of Species.

Darwin: The Descent of Man.

Huxley: Encyclopedia Britannica, "Evolution in Biology."

Huxley: Collected Essays, "Darwiniana."

Haeckel: History of Creation.

Jordan: Foot-notes to Evolution.

Romanes: Darwin and after a Darwin, Vol. I.

LECTURE I.

AN EVENING WITH THE MICROSCOPE.

A demonstration of microscopic forms. The living organisms will be projected through the microscope onto a screen. Opera glasses will be found useful.

"To gaze into that wonderful world which lies in a drop of water, crossed by some atoms of green weed; to see transparent living mechanism at work, and to gain some idea of its modes of action; to watch a tiny speck that can sail through the prick of a needle's point; to see its crystal armor flashing with ever-varying tints, its head glorious with the halo of its quivering cilia; to see it gliding through the emerald stems, hunting for its food, snatching at its prey, fleeing from its enemy, chasing its mate (the fiercest of our passions blazing in an invisible speck); to see it whirling in a mad dance to the sound of its own music—the music of its happiness, the exquisite happiness of living—can any one who has once enjoyed this sight, ever turn from it to mere books and drawings without the sense that he has left all fairyland behind him?"—*Hudson.*

LECTURE II.

DARWINISM AND EVOLUTION; HISTORICAL.

1. Statement of the Problem.—The wealth, diversity and adaptations of animals and of plants; how produced. Naturalists classify living organisms according to their resemblances into groups termed species, but this is only a convenience and is not warranted by any sharp line of demarcation in nature. The old idea of species due to ignorance; variations regarded as nuisances. Despite the enormous number of species, a unity of type is apparent; all forms of animals or of plants can be reduced to a few general plans of structure, or, broadly considered, to one. Is similarity in structure due to identity of parentage?

2. Some answers to the Problem.—The theory of special creation; species were created in the beginning as they exist today. Special creation the belief of Linnaeus; he knew three thousand species, but modern naturalists know hundreds for his every one. Cuvier and the immutability of species. Necessity of explaining fossil forms, the foundation for his doctrine of successive creations and destructions of organisms (doctrine of Catastrophism). Evolution

a theory of the blood relationship of living organisms. It states that the wide variety of existing organisms is due to the divergence of offspring from a common ancestry to form dissimilar groups through the accumulation of variations in successive generations. The idea of evolution is an old one; no one man can be cited as its author. In the theories of the Greeks, Lucretius, Buffon, Erasmus Darwin, Lamarck or St. Hilaire, an adequate explanation of how evolution came about was lacking. Charles Darwin and Alfred Russell Wallace. Darwinism is not synonomous with evolution, but one explanation of how evolution has been effected. A natural law is simply what common sense has shown to be the sequence of events. Darwin's explanation of evolution is founded on universally admitted facts (natural laws), which, were there no further evidence, lead to the conception of evolution as a logical necessity. On the other hand, were the Darwinian theory swept away the evidences of evolution are in no wise shaken.

3. The Starting Point of the Darwinian Theory.—

a. *The new theory of the earth* (Hutton—"Theory of the Earth." Lyell—"Principles of Geology"). Natural agencies now at work were shown to be not only competent to produce the present geological conditions of the earth, but inevitably to have done so.

b. *Similarity in structure and habits between the species of plants and animals* of islands and the species of the neighboring mainland led Darwin to the conclusion that the islands had been colonized from the mainland and that the insular forms had diverged sufficiently from the original stock to constitute different species. Kindred peculiarities of structure between certain fossil and recent animals of South America found their obvious explanation in the view that the recent forms were the modified descendants of the extinct forms.

c. *The power possessed by man of producing deviations from wild types under domestication* (artifical selection). Man produces new breeds of animals or new varieties of plant at will, inducing modifications more marked than those which separate wild species. Though there is a tendency of offspring to resemble parents, no two individuals are exactly alike (heredity and variation). Variations occur in every direction. Man selects such modifications as meet his needs or his fancy and by propagation generation after generation slowly builds up the type he desires; for example, apples, roses, cabbages, poultry, pigeons and dogs.

Variations usually slight; more rarely, marked variations termed saltatory variations or "sports" appear. The breed of Ancon sheep is the result of a saltatory variation. Two-legged dogs of Cincinnati. The question confronted Darwin, if variations are so

universal, is there anything in nature which operates so as to favor certain variations and to suppress others, thus modifying the form or habits of the organism?

d. *Malthus on population.* Malthus pointed out that, unless checked by famine, disease, war or the like, the tendency of population is to increase more rapidly than do means of subsistance. The doctrin of Malthus provibed Darwin with a theory by which to work. It is a remarkable coincidence that this essay led both Darwin and Wallace independently to inquire if there were not similar checks in the case of animals and plants, and if so as to which individuals would survive.

LECTURE III.

THE DARWINIAN THEORY.

1. Living Organisms enormously fertile yet the total number approximately stationary-If the tendency of any one species to increase were unchecked, in a very short time no country could support the product nor the world hold it. The female grasshopper lays on average 100 eggs; if these mature (50 males and 50 females) and multiplication goes on unchecked, at the end of seventeen years the number would be absolutely inconceivable; expressed in weight it would amount to fifteen times the weight of the earth. The roe of a codfish contains 10,000,000 eggs. If the number of the species is to remain constant, it means that of the descendants but two individuals mature to take the place of the parents, for example, only two of the 10,000,000 eggs of the codfish attain maturity.

2. The Struggle for Existence.—A vast majority of the organisms which come into the world are doomed to early death, hence there is fierce competition for existence. The struggle may be either sanguinary or passive, it is inevitable in any event. Checks to increase in plants; in grasshoppers. The microscopic organisms of the ocean are the ultimate food supply of all marine animals. The cycle of life. The threefold nature of the struggle:

a. *Rivals.*—Competition is often severest between individuals of the same species or with closely allied forms (for food, position, mates, etc.).

b. *Hazards of the Chase.*—" * * *

How lizard fed on ant, and snake on him,
And kite on both; and how the fishhawk robbed
The fish-tiger of that which it had siezed;
The shrike chasing the bulbul, which did chase
The jewelled butterflies; till everywhere
Each slew a slayer and in turn was slain,
* * *"

c. *Struggle with Inanimate Nature.*—The past winter has done more to exterminate the quail in Ohio than would a small army of sportsmen in the same time. In human society 600,000 are estimated to have died in two years as the result of a potato famine in Ireland.

3. Variation and Heredity.—Variation and heredity together with the struggle for existence render evolution possible. That variation is widespread in nature is shown by the difficulties of systematists in classifying plants and animals into species. Examples: willows, brambles, fishes, snails. Percentage of variation from measurements of various animals. Examples of variation in man. Variations may affect any part and in any direction. Variation in habits illustrated by the Kea of New Zealand. The origin of variations is the fundamental question in evolution, but one which has never been satisfactorily answered. The following factors have been suggested:

a. *Dual ancestry.* Offspring derived from two ancestors, a blend or compromise between the parents.

b. *An inherent tendency to vary.* The instability of living matter.

c. *Use and disuse of organs.* A questionable factor.

d. *The direct action of environment.* An unknown quantity Changes in nutrition, etc., in many plants may be followed by variation.

Darwin's theory not an endeavor to explain variations, but to determine the factors which direct variations.

4. Natural Selection (*Darwin*), or Survival of the Fittest (*Spencer*).—Of the vast number of individuals which must battle for a place in the world, some possess advantageous variations in certain directions and are in consequence able to surpass their competitors. The favorable features are handed down to descendants and intensified so long as they continue to be advantageous. Thus, organisms become more and more perfectly adapted to the conditions of life. In artificial selection man chooses, in natural selection the process is brought about automatically through the struggle for existence; the weak, the inexpedient, the ill adapted are eliminated, the forms most in harmony with their surroundings survive. Natural selection well illustrated by the wingless insects of the Kerguelen islands and of Madeira. How the grasshopper got its color. Adaptations in nature concerned mainly with:

a. *Procuring food.*
b. *Perpetuation of the race.*
c. *Self-protection.*
d. *Adjustment to physicial surroundings.*

The world of guile; protective coloration (general); leaf butterflies, stick caterpillars, etc.; aggressive coloration; warning colors; mimicry ; lures. Occupancy of a given region an important advantage to a species and survival may be "Survival of the Existing" (Jordan), and not necessarily "Survival of the Fittest." Natural selection regarded by Darwin as the most powerful agent in organic evolution.

5. Changing Environment Necessitates Continued Structural Modifications.-Perfect adaptation impossible; living organisms must continually adjust themselves to the shifting conditions of life.

a. *Climatic Changes.*—The former warm climate of Greenland. Much of North America modelled by moving ice, hence former climatic conditions unlike the present.

b. *Geographic Changes.*—Alternate lifting and depression of the earth's crust. Changes in the vicinity of Cincinnati. Isolation; the fauna of islands. The removal of barriers.

c. *Fluctuations in Food Supply.*—The advantages and disadvantages of specialists; the giraffe and the ant-eater.

d. *Destructive Checks.*—A saturation point, so to speak, is reached sooner or later by a species in a given region; loss exactly balances increase. The diminution of destructive checks may allow disturbance of this equilibrium of nature. Spread of the English sparrow in America. Scale insects. Weeds.

If certain members of a species meet the conditions of life by variation in one direction and others, in other directions, then the continued action of natural selection must in time lead to sufficient divergence betwen the forms to make them rank as separate species. This is what Darwin means by "Origin of Species." The same process continued through the millions of years which have elapsed since the first life appeared on the globe is sufficient to have given rise to the entire diversity of the life of to-day.

6. Summary of the Argument.—Wallace's chart.

FACTS.	CONSEQUENCES.
a. Rapid increase of organisms. *b.* Total number stationary.	Struggle for Existence.
c. Struggle for existence. *d.* Variations with heredity.	Survival of the Fittest or Natural Selection.
e. Survival of the fittest. *f.* Changing environment.	Structural modifications leading to Origin of Species.

LECTURE IV.

EVOLUTION: EVIDENCE FROM THE PRESENT STRUCTURE AND DISTRIBUTION OF ANIMALS.

1. The Present State of Opinion.—That existing plants and animals are the modified descendants of more primitive forms is now universally conceded. The greatest uncertainty is as to how the various changes have come about. Origin of variation is the primary factor. Darwinism (natural selection) is widely accepted as one of the most important secondary factors. The search for unknown factors; the apparent purposeful character of certain variations.

2. The Classification of Animals.—Classification consists in grouping animals according to similarity in fundamental structure. A species is the smallest group to which constant characters (not sexual) can be assigned; genera are groups of species possessing features in common; on this same principle of inclusion families, orders, classes and phyla are successively constructed. The entire system is conventional and as we learn more about animal forms we find that the groups merge imperceptibly into one another. The only plausible explanation of the facts is that varieties diverge slowly to form species which in turn become sufficiently different to be ranked as separate genera and thus gradually the whole kinship of life has been established.

3. Similarity in the Architecture of Animals.—Structural correspondence of organs (homology) is the most striking feature of animal forms. The skeleton of vertebrates retains its fundamental plan although it may be modified into almost every conceivable variety to serve a great diversity of functions. The hand of man, the paddle of the whale, the wing of the bat, etc., are fundamentally the same. Comparisons of higher invertebrate (articulated) types show a common plan of organization. Beginning with the simplest animals, a progressive series may be roughly constructed as follows: protozoa, lower invertebrates (double-walled sac type), higher invertebrates (double-tube type), vertebrates.

4. The Distribution of Animals.—Not only distribution throughout the various geographical provinces of the earth, but also vertical distribution (mountain-top, valley, depth of the sea, etc.,) is included. Present distribution intelligible only upon the theory that through migration from one parental source to new conditions and through subsequent multiplication and modifications, the kindred species, genera, etc., which occupy the same or adjoining areas, have arisen. Great importance of barriers. Peculiarities of the fauna of oceanic islands can be explained only upon the principles of distribution; absence of amphibia and terrestrial

mammals, presence of flying mammals and birds. Relation of island forms to the nearest mainland.

5. Some Recent Problems in Distribution: Base Levelling.—Tendency of elevated level tracts to be reduced to a base level by the action of rivers and streams. Thus cliffs and valleys are formed and the animal and plant inhabitants must meet the very different new conditions. Divides may finally be surmounted and the fauna of the two sides mingle. The separation of river systems has played an important part in the distribution of many animals, for example, the snails of the South-eastern United States.

6. Conclusions.—The natural system of classification, the structural affinities of living organisms and their present distribution, all point to community of descent.

LECTURE V.

EVOLUTION; HISTORICAL EVIDENCE.

1. Nature of the Evidence.—Historical evidence conveniently classified into (*a*) history of the race (geological record) and (*b*) history of the individual. The living forms about us today are but the temporary expressions of a flow of life which began in the remote past. The paleontologist finds evidence of this in the rocks and the embryologist sees it indelibly stamped on each new organism that appears.

2. The Testimony of Ancestors.—Fossils are the preserved remains of the former inhabitants of the earth and consist for the most part of hard substances preserved in nearly their original state, or of less permanent parts which have been replaced by mineral matter. They are found in the various strata which make up the crust of the earth. There is a general advance in the organization of fossils from lower to higher strata. Recent fossils are closely allied to the modern plants and animals, likewise the forms found in successive geological periods are very evidently related. Moreover, as they occur deeper in the series of rocks, they converge more and more toward a common ancestry. Imperfection in the geological record:

(*a*) *Our knowledge is more imperfect than the actual record* (material, inaccessible or unexplored).

(*b*) *The chances against preservation are many.* But few forms die in suitable localities. Most soft animals leave no trace. Many others are devoured or dissolved.

(*c*) *To preserve a series of forms the deposits must extend over a very long time.*

(*d*) *It is extremely hard to distinguish between lineal descendants and collateral kinsmen* (parents from uncles and aunts).

(*e*) *The shifting of the various strata may lead to misinterpretation.*

In general the geological succession of animals from the simplest to mammals may be indicated as follows: Single-celled animals (protozoa), lower invertebrates, higher invertebrates, fishes, reptiles, mammals.

3. The Life History of the Individual.—The tadpole of the common frog, is practically a fish (two-chambered heart, gills, etc.), hence the frog repeats a fish stage in the course of its development. Higher vertebrates go through both a fish and a frog stage (gill-clefts and two-chambered heart followed by lungs and three-chambered heart, etc.). All vertebrates, moreover, in the course of their development pass through the following well-marked primitive stages beginning with the simplest type of organism: A single cell, a ball of cells, a double-walled sac, a double tube and lastly the successive vertebrate stages, if the form is of the highest type of vertebrate. This sequence is also the same as that seen in the grades of structure observed among living animals and in the successive appearance of animals in the history of the earth. In other words, the developing individual passes through its successive ancestral stages. The presence of rudimentary or vestigeal organs which are useless to the possessor are explained by this tendency of living forms to repeat ancestral characters. Falsification of the ancestral history may occur through condensation, omission or distortion of ancestral stages.

4. Summary of Conclusions From the Structure and From the Racial and Individual History of Animals.

Fundamental Sturucture	Single Cell.	Double-walled Sac.	Double-tube Type.	Vertebrate		
				Two-chambered heart. gillclefts	Three-chambered Heart. Lungs.	Four-chambered Heart. lungs.
Gradation of structure in living animals. (Classification)	Protozoa	Lower Invertebrate	Higher Invertebrate	Fish	Reptile	Mammal
Order of appearance of animals in the history of the earth (Geology.)	Protozoa	Lower Invertebrate (structure?)	Higher Invertebrate	Fish	Reptile	Mammal
Stages in the development of a mammal.	Egg	Lower Invertebrate	Higher Invertebrate	Fish	Reptile	Mammal

LECTURE VI.

THE DESCENT OF MAN.

1. The Zoological Position of Man.—Man is distinctly an animal, a vertebrate and a mammal in structure and functions. Arguments concerning the origin of man are of the same general nature as those used to substantiate the descent of other animals. Structurally, man differs less from the higher apes than do they from the lower. His body a veritable memorandum of his past existence; about seventy rudimentary organs are homologous to kindred organs which are functional in lower animals. In his individual development, man like other mammals starts as a single cell and ascends the entire scale of transformation (fish stage, reptilian stage, etc.). The evidence from fossil remains of prehistoric man is incomplete but recent discoveries tend to confirm the fact that man is the outcome of natural evolution.

2. Some Possible Factors in the Evolution of Man:—

(*c*) *Dependence upon cunning* rather than upon strength would quicken intelligence.

(*b*) *Use of tools and weapons* and development of instincts to build shelter.

(*c*) *Prolonged infancy* would call forth parental solicitude.

(*d*) *Social life.*

(*e*) *Language.*

3. Evolution of Mind.—All living organisms possess the power of response to external stimuli. Stimuli are for the production of activity and the degree of the response depends upon the nature of the responding mechanism. Such activities as are for the good of the organism preserve it, those which are harmful lead to its destruction. Variation in the nature of responses occur and this makes specialization possible through the accumulation of serviceable variations in one direction. The mechanism for response must always be efficient for the work that is to be performed. In plants and the simplest animals the mechanism is largely unspecialized and the responses, though adequate, are very limited in range. In the higher animals, through the physiological division of labor, a number of special elements are set apart for the perception of different external stimuli (sound, light, odor, etc.), and in degree as each aids in the preservation of the possessor it will become more effective, because the organism it has preserved will live and hand it down as an heirloom to the succeeding generation to be again the conserver of those individuals which possess it in the greatest degree. Experience is attained through the activity of our senses. We *know* only through our experience or the experience of others expressed in terms of our own experience.

Thus all knowledge, all interpretation of phenomena about us, must be based on experience. Science itself is but the experiences of man arrangd in orderly form.

4. Ethical Aspect of Darwinism.—The struggle for existence does not cease with the introduction of social institutions. Co-operation is a powerful aid to the safety of the participants. The existence of an organism is conditioned by its reactions to the realities of the external world. The accuracy with which it determines these realities depends upon the degree of perfection of its sensations. The sane man, the man with normal responses to the objective world, will in the end survive. That he has survived is proof that his ancestors have found safety through the action of their sensory mechanism. All defects in nervous responses lead to action based on false perception and consequently hazard life. Insanity means death. Not sentiment but sanity must deal with social problems. The importance of conventionality in society means that it is a tried course along which safety has been found; herein lies one value of the authority of the church for the masses. Fear of the unknown and worship of invisible powers has restrained the instinctive tendencies of man and aided in rational self-control. Unrestrained impulse means destruction. A living organism, as already noted, is constructed to respond to its environment; for example, light renders the development of eyes possible; there is air to breathe and there are organs for breathing it; a fish must have gills, and an animal lungs, for obtaining it. So, too, the mental part of an organism is conditioned by its environment and a man developed under one set of conditions cannot be expected to possess the same mechanism and show the same responses as his neighbor whose training and general condition of life have been very different. Both will arrive at part of the truth and neither at all of it. The imaginary conflict of science and religion, or the differences between monism and dualism are doubtless due to this fact. Various men may see the same truth but proclaim it "each in his own tongue."

> "A fire-mist and a planet—
> A crystal and a cell,—
> A jelly-fish and a saurian,
> And caves where the cave-men dwell;
> Then a sense of law and beauty,
> And a face turned from the clod,
> Some call it Evolution,
> And others call it God."

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